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RECOMBINATIVE GENERALIZATION OF WITHIN-SYLLABLE UNITS IN NONREADING ADULTS WITH MENTAL RETARDATION

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Two adults with mental retardation demonstrated the recombination of within-syllable units (onsets and rimes) using a spoken-to-printed-word matching-to-sample (MTS) procedure. Further testing with 1 participant showed comprehension of the printed words. Printed-word naming was minimal before, but greater after, comprehension tests. The findings suggest that these procedures hold promise for further basic and applied analyses of word-attack skills.

DESCRIPTORS: recombinative generalization, reading, stimulus equivalence, mental retardation

There is little published research on the acquisition of word-attack skills in individuals with mental retardation. Recombining print–sound correspondences is a critical component of word-attack skills. In the present study, 2 nonreading adults with mental retardation participated in the systematic replication of a study that demonstrated recombinative generalization of within-syllable print–sound correspondences in prereading children (Mueller, Olmi, & Saunders, 2000). In a matching-to-sample (MTS) task, the children learned to select each of four printed words upon hearing them spoken (e.g., *mat*, *sat*, *sop*, and *sug*). The trained words contained the onsets (the initial consonant sound) and rimes (the remainder of the syllable, i.e., *at*, *op*, and *ug*) of test words. In tests for recombinative generalization, the children correctly selected novel combinations of the onsets and rimes in the training words (e.g., *mop*, *mug*).

Using stimulus equivalence procedures, the Mueller et al. (2000) study demonstrated additional untrained performances involving the printed words (e.g., Sidman, 1971). In the absence of feedback, the children matched the printed words to pictures, and then named most of the printed words. Similar procedures were used in the current study to teach print–sound correspondences to adults with mental retardation.

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GENERAL METHOD

Participants

Ally, age 27 years, and Lee, age 35 years, had mild mental retardation. Their age-equivalent scores were 7-4 and 6-6 on the Peabody Picture Vocabulary Test. On the sight word subtest of the Woodcock Reading Mastery Tests—Revised, Ally's and Lee's age equivalents were 6-1 and 6-5. Neither passed any item on the word-attack subtest.

Table 1
Word Sets

					Testing			
Set	Training words				Generalization		Distracters	
1	mat	sat	sop	sug	mop	mug	sop	sug
2	mug*	sug	sot	sap	mot	map	sot	sap
3	map	sap	sum	set	mum	met*	sum	set
4	pat*	mat	mop*	mug	pop	pug	mop	mug
5	pub	mug*	mot	map	pot*	pap	mot	map
6	pap	map	mum	met	pum	pet	mum	met
7	hat	rat*	rop	rug	hop*	hug	rop	rug
8	hug*	rug	rot*	rap	hot	hap*	rot	rap

Note. The 22 underlined words were in comprehensive word-naming pretests. Because Ally stopped responding, the asterisked words were not presented to her. Note that some of the generalization words appear as training words in a later set, so more than 22 entries are underlined.

General Procedure

Sessions were conducted daily in a small, private room, using a computer with a touch-sensitive monitor. Visual stimuli were presented in the center and in each of the four corners. Print stimuli were 1.5-cm lowercase black letters. Spoken-word samples were presented by the computer via external speakers.

MTS sessions had 60 trials and four choice stimuli. In training sessions, every correct response produced a series of tones; after approximately every 2.5 correct responses, a nickel was delivered automatically. Incorrect responses produced a brief darkened screen. There was no feedback in test sessions, after which participants were paid a lump sum based on accuracy.

Study 1: Recombinative Generalization

The conditions were the same as in Mueller et al. (2000) except that there were eight word sets instead of six. Table 1 shows the four training words and two generalization test words in each word set. In generalization test trials, the two distracter words appeared as choices but never served as the correct choice. Before the comprehensive pretests, several sessions familiarized participants with MTS procedures and ensured all task-relevant discriminations (see Familiarization Training [Appendix] and Phase 1 in Mueller et al.).

Comprehensive Pretests

Comprehensive pretests (Phase 2 in Mueller et al., 2000) assessed participants' accuracy on all of the word sets to be used in the study.

Word naming. The 22 words underlined in the table were presented individually on the screen. Lee named *rat* and *pat* correctly. Ally stopped after 12 words; she named *sat.*

Spoken-to-printed-word MTS. The generalization words are shown in the fifth and sixth columns of Table 1; each was the sample once per session. Accuracy is shown by the striped bars in Figure 1. Ally averaged 64% correct across three test sessions. Lee averaged 50% across two. Because Lee completed training and testing for only the first four word sets (she moved), we present pretest data from those sets only. For both women, most errors involved selecting the word with the same onset as the sample (i.e., the participants excluded the two distracters with different onsets).

Pretests, Training, and Posttests for Each Word Set

After the comprehensive pretests, word sets were studied one by one (Phase 3 in

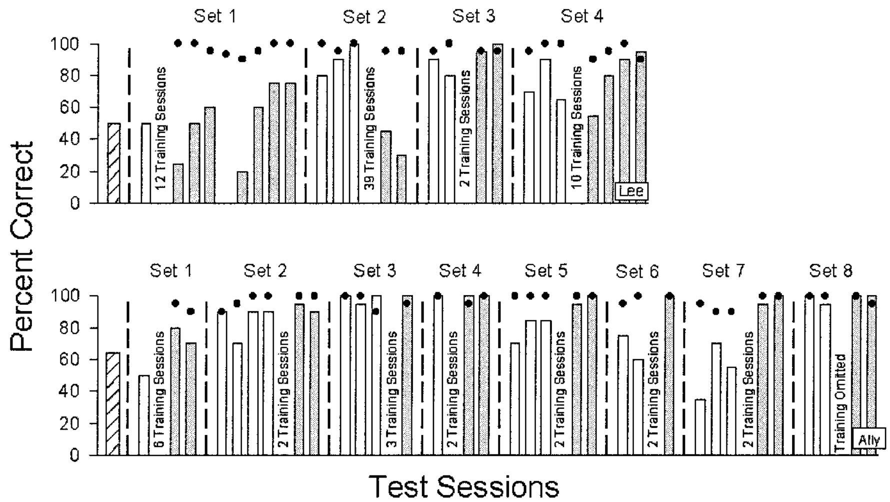

Figure 1. Accuracy on spoken-to-printed-word MTS trials for both participants. The striped bars show accuracy on the comprehensive pretest. The white and gray bars show generalization test-trial accuracy for the individual word set pretests and posttests, respectively. The dots indicate accuracy on trained words. The number of training sessions required for criterion accuracy on the training words is also shown. Note that test trials were not presented in Lee's fourth posttest for Set 1, because she made more than two errors on the trained words presented in the first 20 trials of the session.

Mueller et al., 2000). First, there was an MTS pretest (except that Set 1 pretest data came from the comprehensive pretest). In the word-set pretest, the first 20 trials reviewed training words from the previous set. If review-word accuracy was at least 90%, the final 40 trials mixed 20 review and 20 generalization test trials (10 of each generalization word in the current set). If accuracy was less than 90% on the first 20 review trials, test trials were omitted; the final 40 trials presented review words only.

Next, spoken-to-printed-word MTS training occurred for the training words. Finally, posttests were presented. These were identical to pretests, except that review trials were replaced with training words from the current set. Testing stopped either when accuracy was 100% or when there was no increasing trend across two to three sessions. Note that training and posttesting occurred even if accuracy was high in the pretest, because the current-set training words were not in the pretest.

Figure 1 shows accuracy on the generalization-word MTS pretests (white bars), the number of sessions required to teach the training words, and accuracy on generalization-word posttests (gray bars) for each word set. Beginning with the third word set for both participants, posttest accuracy always reached at least 90%. Beginning with Set 2, both showed high accuracy in some pretests—an improvement over the low accuracy shown in the comprehensive pretests. As discussed in Mueller et al. (2000, p. 527), this presumably was due to recombination *within* rimes of previous word sets.

Printed-word naming tests, in which each trained word and test word in the set was presented twice, were presented after the recombinative generalization posttest for each word set (not shown in Figure 1). Ally averaged 12% and Lee averaged 17% correct.

Study 2: Printed-Word Comprehension and Additional Word-Naming Tests

As in Phase 4 of Mueller et al. (2000), we used equivalence procedures to test rudimentary printed-word comprehension, followed by additional word-naming tests. Ally participated. Word Sets 7 and 8 were tested separately. Previously, Ally's naming accuracy for words in Sets 7 and 8 was 8% and 25%, respectively. The comprehension tests required Ally to select the picture that corresponded to a printed-word sample (print–picture). To prepare for the tests, we first trained spoken-word-to-picture matching. In the present study, arbitrary pictures were assigned for nonsense words (Mueller et al. eliminated nonsense words). In Set 7, *rop* was an abstract symbol and in Set 8, *hap* was a clown.

Test sessions had 20 four-choice print–picture test trials mixed in a baseline of spoken-word-to-picture and spoken-word-to-printed-word trials. Baseline accuracy was always 100%. Trained words and generalization words were tested in separate sessions. For Set 7, comprehension accuracy was 95% for the trained-word tests but averaged 43% across three generalization-word (*hop/hug*) test sessions. We presented 10 additional baseline training sessions, after which generalization-word test accuracy averaged 90% in three test sessions. A retest of printed-word naming showed an increase in accuracy from 8% to 40%; interestingly, Ally now emitted "jump" in the presence of the printed word *hop*. After two more print–picture tests, word-naming accuracy increased to 75% (she missed *hat* once and *rop* twice). Finally, we presented five sessions in which Ally was taught to name the pictures, using the names used in the spoken-word-to-picture sessions. At first, she missed *rop* ("don't know") and *hop* (she said "jump" and quickly self-corrected). Occasional errors on the *rop* picture persisted to the fifth of six training sessions for picture naming. In the final word-naming test (after picture naming was 100%) accuracy was 92%.

We next replicated the key features of the Set 7 procedures with Set 8. Print–picture accuracy was 90% in both the trained-word and generalization-word sessions. Subsequently, accuracy on printed-word naming tests increased from 25% to 50%. Next came picture-naming training. The names she emitted at first differed from those used in the spoken-word-to-picture and spoken-word-to-printed-word trials for three of the six words. For *hap*, *rot*, and *hot* she said "clown," "rotten," and "fire," respectively. By the fourth session of picture–name training, all of her names were consistent with ours. Next, in the final reading test, she made four errors (75%), three of which involved the names that she had assigned to the pictures.

GENERAL DISCUSSION

In the spoken-to-printed-word MTS task, both participants showed low accuracy on the comprehensive pretest of the generalization words. Both showed substantial increases in generalization-word accuracy once training began. Such recombination is a crucial prereading skill. There has been no previous study of the recombination of within-syllable units in individuals with mental retardation, although a recent study showed the promise of the procedures for teaching spelling to a child with autism (Kinney, Vedora, & Stromer, 2003).

Additional procedures involving 1 participant showed high accuracy on comprehension (print–picture) tests, which apparently improved accuracy in the printed-word naming tests. There was further improvement in word naming after picture naming was taught. In testing and then teaching picture naming, we found that Ally did not emit the spoken name that was being used in the MTS sessions for several of the pictures (even though she selected the pictures correctly). Moreover, Ally's printed-word and picture-naming "errors" tended to correspond (*rop* in Set 7 and *rot* and *hap* in Set

8). This was most likely with unfamiliar words.

Incorporating spoken-word-to-picture and printed-word-to-picture tasks into the teaching mix increased the number of printed words named correctly. However, our findings suggest potential practical limitations of the equivalence procedures if the goal is to promote word-attack skills. The nature of errors—naming the printed-word *hop*, "jump," for example—suggests that including pictures may promote sight-word reading rather than word-attack skills. In contrast, the MTS recombinative generalization procedures appear to hold promise for the basic study of word-attack skills and for the computerized instruction of foundation skills for decoding.

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